Building a Better Blueberry

Scientists with ARS have recently worked out a system to regenerate blueberry plants from plant tissue taken from the commercially important cultivar, Bluecrop.

Regeneration is a delicate but necessary process used to produce whole plants from cells that have been pegged as genetically superior or have undergone genetic improvement. It is important to scientists working to develop cultivars endowed with desirable genetic traits.

Though an efficient system for regenerating plants had been devised for several other blueberry cultivars, it did not work for Bluecrop until recently.

Bluecrop is known for its widespread acreage and its good fruit yield nationwide. It is the most widely grown highbush blueberry in the United States.

Among other projects, scientists with ARS' Fruit Laboratory in Beltsville, Maryland, are using gene transfer followed by the regeneration process to study blueberry genes believed to be associated with cold tolerance. Plant physiologist Freddi A. Hammerschlag heads the project. She and plant geneticist Lisa J. Rowland hope to improve Bluecrop's already good cold tolerance.

PEGGY GREB (K9983-3)

Geneticist Lisa Rowland (front) and horticulturist Elizabeth Ogden collect blueberry plant leaf tissue for DNA analysis.

The process starts by developing many Bluecrop shoots with which to work. Tiny shoots, which are actively growing vegetative buds, are put into large tissue culture dishes containing nutritive ingredients. Inside, the shoots grow and propagate. Next, tiny sections called explants are taken from shoots of the propagated test plants and placed onto a regeneration medium. It was explants from these Bluecrop shoots that ultimately proved to regenerate.

"We applied a two-step pretreatment to the tissue before its transfer onto the medium. That was key to enabling regeneration," says Hammerschlag.

The Chemistry of a Media Darling

Blueberries are increasingly popular as more consumers reach for the fruit that's high in antioxidants and long on taste. Antioxidants shield cells from the plundering effects of free radicals. These rogue molecules corrupt healthy cells—a process that ultimately underlies cellular aging. With such high-stakes health benefits, it's no wonder blueberries have become a media darling among the food press.

Blueberries are among the fruits and vegetables highest in antioxidant capacity, according to tests developed by ARS, says Ronald L. Prior, chemist with the Arkansas Children's Nutrition Center in Little Rock.

Preliminary research in rats shows blueberries may also improve cognitive function—a term scientists use for mental capacities, such as memory and concentration.

"Our research on aging shows that blueberry supplementation at about 1 to 2 percent of the diet may reverse short-term memory loss and improve motor skills," says James A. Joseph, physiologist at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University in Boston, Massachusetts.

Consumption has never been higher. More cultivated fresh blueberries and more frozen wild ones were consumed or purchased through U.S. supermarkets last year than ever before, according to industry experts. U.S. growers produce about 350 million pounds of blueberries worth between $187 million and $260 million annually.

Blueberry's powerful nutritional punch is likely due to the fact that its antioxidants come in the form of both long-established vitamins *and* newly defined phytochemicals. The berries are particularly well endowed with a series of phytochemicals called anthocyanins—the source of their blue, purple, and red pigments—and proanthocyanins.

PEGGY GREB (K9984-1)

ARS Fruit Lab researchers devised a method for regenerating the Bluecrop blueberry cultivar from tissue culture. Here, technician Stephanie Ray (left) and plant physiologist Freddi Hammerschlag examine Bluecrop shoots growing on a medium.

Now the team is building on that success.

Rowland has identified and isolated several genes from other blueberry cultivars that are believed to be involved with cold tolerance. Hammerschlag has developed a procedure to promote transfer of one of the new genes into Bluecrop cells. She then takes cells that receive the new gene and puts them onto a regeneration medium containing various additives, such as nutrients and growth regulators.

The last step is regenerating new plants endowed with the introduced gene. During this end stage, the regeneration medium includes an ingredient that targets growth. "Only the cells containing the new gene can develop, regenerate, and thrive," says Hammerschlag. The final phase is to evaluate whether full-fledged plants grown from the gene-enhanced cells perform better under colder-than-normal conditions.

Improving cold tolerance is a challenging science. For example, the developers of the cultivar Arlen, named after retired USDA blueberry geneticist Arlen Draper, hoped the plant would flourish in New Jersey. But Arlen was not sufficiently winter hardy to grow in that region, so it was released to growers farther south, in North Carolina.—By **Rosalie Marion Bliss,** ARS.

This research is part of Plant Biological and Molecular Processes, an ARS National Program (#302) described on the World Wide Web at http://www.nps.ars.usda.gov.

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Also, blueberry is one of the few fruits that contain so wide a spectrum of anthocyanins, which fall within a phytochemical class called flavonoids. Another class, carotenoids, makes carrots and pumpkins orange.

Naturally, the amount of nutrients in any crop may differ among varieties or because of growing conditions, such as geographic location and soil content. Still, while many fruits contain only about 3 to 6 individual anthocyanins, various cultivated blueberries contain about 15 on the low end, rising to about 25 in wild blueberries, says Prior.

In test tubes, these anthocyanins yield about 2 to 2.5 times the antioxidant power of vitamin C. The next step, now under way, is to assess the bioavailability of these antioxidant heavyweights. Bioavailability refers to how well the body digests, uses, and stores a given chemical. Stay tuned.—By **Rosalie Marion Bliss,** ARS.

One Cup of Blueberries Contains

NUTRIENT	QUANTITY	DAILY VALUE*
Calories	81	4 %
Dietary Fiber	4 g	17 %
Vitamin A	145 IU	3 %
Vitamin C	19 mg	32 %
Anthocyanins	178 mg	ND**
Proanthocyanins	460 mg	ND

*Daily Value is a dietary reference to help consumers use food labels to plan a healthy diet. Daily values are based on a 2,000-calorie diet. Caloric needs vary by individual.

**ND = Not determined at this time.